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Simultation of the Transport of Halogen Species from the Equatorial and Mid-Latitude Stratosphere to the Polar Stratosphere in a Two-Dimensional Model

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The bulk of O_3 destruction in the Antarctic stratosphere takes place in the lower stratosphere between 15 and 25 km. Both O_3 and the halogen reservoir species have their origins in the higher altitude region (20-30 km) in the equatorial and mid-latitude stratosphere. Using the Caltech-JPL two-dimensional residual circulation model, we investigate the growth of stratospheric halogen due to the increase of $CFCl_3$ and CF_2Cl_2.

The model has 18 latitudes (pole to pole) and 40 vertical layers (0 to 80 km). It was run from 1972 to 1988, with $CFCl_3$ and CF_2Cl_2 specified at the lower boundary

$$F11(t) = 96.5 + 9.0 \times t \quad ,$$
$$F12(t) = 162.7 + 15.3 \times t \quad ,$$

where the mixing ratio is given in pptv and t is in years since 1972.

Preliminary conclusions are:

(a) Between 1976 and 1987 the column abundance of HF at 45 N increased by 6 x 10^{14}cm^{-2} (see Fig. 1a) compared with an observed increase of 4 x 10^{14}cm^{-2} (Zander *et al.*, 1987a).

(b) In the same period the column abundance of HCl at 45°N increased by 9 x 10^{14}cm^{-2} (See Fig. 1c), compared with an observed increase of 7 x 10^{14}cm^{-2} (Zander *et al.*, 1987b; Farmer, 1988 private communication).

(c) The corresponding increases in HF and HCl at 85 S are 1.4 x 10^{15} and 1.7 x 10^{15} cm^{-2} respectively.

(d) The increase of free fluorine (F_x) and free chlorine (Cl_x) occurs above 25 km at midlatitudes, but occurs much deeper in the atmosphere at 85 S. (see Fig. 2).

References:

Zander, R., G. Roland, L. Delbouille, A. Sauval, C.B. Farmer and R.H. Norton, 1987a. Monitoring of the integrated column of hydrogen fluoride above Jungfraujoch Station since 1977 - the HF/HCl column ratio. *J. Atmos. Chem.* 5, 385-394.

Zander, R., G. Roland, L. Delbouille, A. Sauval, C.B. Farmer and R.H. Norton, 1987b.. Column abundance and the long-term trend of hydrogen chloride (HCl) above the Jungfraujoch Station. *J. Atmos. Chem.* 5, 395-404.

Figure Caption:

Fig. 1a. Column abundance of HF at 45 N due to increase of $CFCl_3$ and CF_2Cl_2 in the atmosphere.
Fig. 1b. Same as Fig. 1a, for 85 S.
Fig. 1c,d. Same as Fig. 1a,b for HCl.
Fig. 2a. Vertical profile of F_x at 45 N and 85 S in Jan 1987 derived from $CFCl_3$ and CF_2Cl_2.
Fig. 2b. Same as Fig. 2a, for October 1987.
Fig. 2c, d. Same as Fig 2a,b for Cl_x.

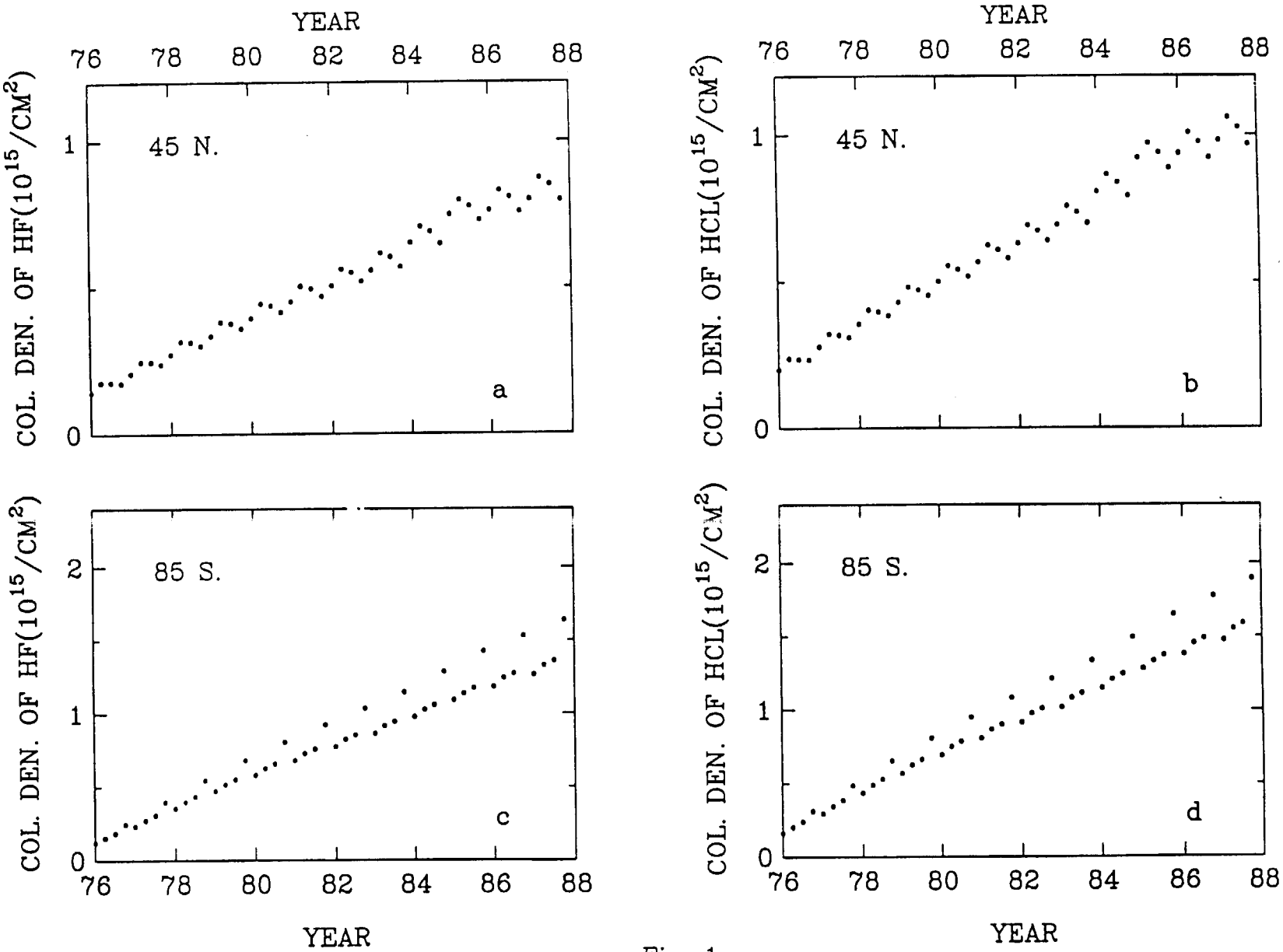
YEAR
76 78 80 82 84 86 88
45 N.
a
COL. DEN. OF HF(10^{15}/CM^2)
0
1
b
COL. DEN. OF HCL(10^{15}/CM^2)
85 S.
c
2
d
YEAR

Fig. 1

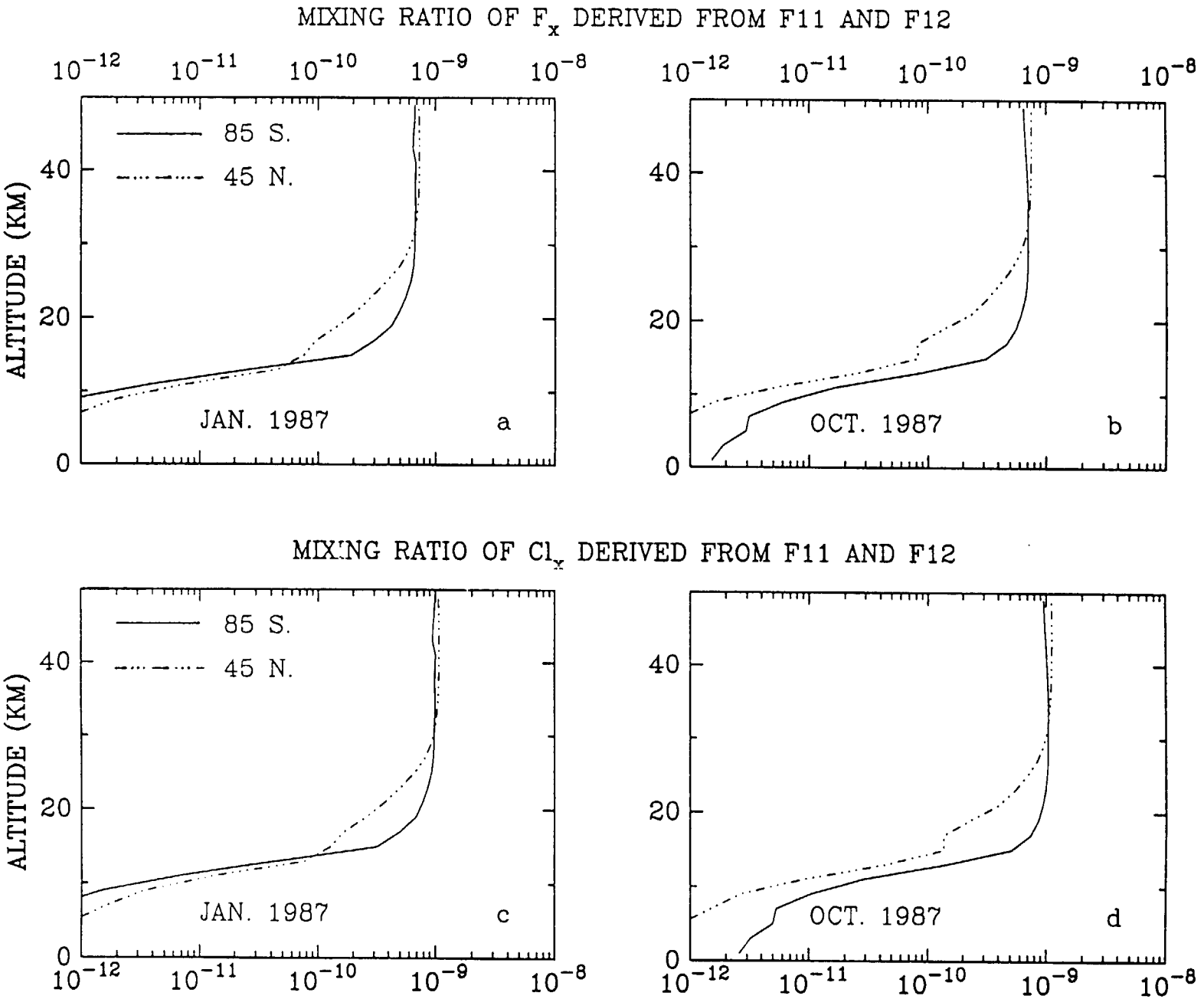
MIXING RATIO OF F_x DERIVED FROM F11 AND F12
10^{-12} 10^{-11} 10^{-10} 10^{-9} 10^{-8}
85 S.
45 N.
ALTITUDE (KM)
0
20
40
JAN. 1987
a
OCT. 1987
b
MIXING RATIO OF Cl_x DERIVED FROM F11 AND F12
c
d

Fig. 2